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THE SOVIET CHALLENGE IN SPACE

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ABSTRACT

Huntsville, Alabama, represents the heart and soul of the American drive to become a space-faring nation. It is also a symbol of our dedication to making this an international effort open to the participation of all mankind. It has come to its important role out of dreams in the United States, in Germany, and in a number of other countries. Although Huntsville now has impressive facilities for developing and testing the free world's largest launch vehicles, more than anything else, it has a team of people working in partnership who have combined their dreams with great engineering practicality and thoroughness, and with unmatched persistence in efforts extending over many years. We have certainly come a long way down the development road, and yet we know this is still a pioneering effort, with the best yet to come.

It is my purpose to discuss some aspects of the efforts of another great team to achieve practical space flight, and to compare that development with our own. Even with the secrecy which surrounds much of that effort, essentially the same basic technology drawn from a common world heritage is being employed.

What we are doing to achieve space flight is well worth doing on its own merits. But all of us would be less than human if we were not curious about the approaches and the results of another strong team in a similar effort. And I think we all share a desire that we be first in space both as a personal challenge and because it has inescapable implications for the well-being of our Nation.

NASA - GEORGE C. MARSHALL SPACE FLIGHT CENTER

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By

Dr. Charles S. Sheldon

RESEARCH PROJECTS LABORATORY
RESEARCH AND DEVELOPMENT OPERATIONS

BIOGRAPHICAL NOTE

Dr. Charles S. Sheldon has been a particularly astute scholar of the activities and accomplishments of the USSR. Dr. Sheldon, who is a member of the Professional Staff of the National Aeronautics and Space Council in the Executive Office of the President, has an extremely rich and diversified past. He was born in China. He received his schooling at the University of Washington and Harvard. He spent some time at the Naval Intelligence School, part of the Postgraduate School of the Navy, at California Technical Institute and at the Guided Missile School in Fort Bliss. He is a member of Phi Beta Kappa and Pan Xenia, the international foreign trade honorary.

Dr. Sheldon's major field is economics. His experience includes such a long list that it would take a good deal of time to cover it thoroughly. To mention a few highlights: He was a trade analyst of the Port of Seattle Commission, he was in the department of economics at the University of Washington, a consultant of the Sabena Belgian World Airlines, and the director of the Institute of Maritime Commerce and Transportation. These are a few of his many activities. His military experience includes being a waterfront officer at the Naval Supply Depot in Oakland, and staff member of Naval Intelligence School in Anacostia.

At present, Dr. Sheldon is a Captain of the United States Naval Reserve, with 23 years of service. Other Federal service includes Chief of the Pacific Section of the Cargo Requirements Division, War Shipping Administration, staff economist of the Joint Economic Committee of the U. S. Congress and then, very importantly, the assistant director and later technical director of the Committee on Science and Astronautics in the House of Representatives; and since 1961, member of the professional staff of The National Aeronautics and Space Council, Executive Office of the President. Publications that Dr. Sheldon has authored are equally impressive and cover an equally long list. Among them are International Air Transportation, The Japanese Shipping Industry, The National Space Program, Space Handbook, Next Ten Years in Space, The First Soviet Moon Rocket, Military Astronautics, Manned Spaceflight in the Context of National Goals, and most recently, The Challenge of International Competition, and Overall Economic Outlook in Space in the Fiscal Year 2001. He has been associated with two early space programs. One was the Argus Project and the other the Vela Hotel Project. Both of them included military concepts of radiation, artificial radiation in space.

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THE SOVIET CHALLENGE IN SPACE

SUMMARY

Huntsville, Alabama, represents the heart and soul of the American drive to become a space-faring nation. It is also a symbol of our dedication to making this an international effort open to the participation of all mankind. It has come to its important role out of dreams in the United States, in Germany, and in a number of other countries. Although Huntsville now has impressive facilities for developing and testing the free world's largest launch vehicles, more than anything else, it has a team of people working in partnership who have combined their dreams with great engineering practicality and thoroughness, and with unmatched persistence in efforts extending over many years. We have certainly come a long way down the development road, and yet we know this is still a pioneering effort, with the best yet to come.

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INTRODUCTION

I would like to say just a word about the Space Council, which is where I work. The Space Council was created at the same time as NASA, but as a

separate organization attached to the White House. Under the present version of the law it is chaired by the Vice President of the United States, and the other four members are the Secretary of State, the Secretary of Defense, the Administrator of NASA, and the Chairman of the Atomic Energy Commission. It is concerned with high level policy. NASA is only one of our clients. The Department of Defense, another major operator in space, is equally involved in the work of the Council. Our purpose is to do several different things when requested by the President: Namely, to keep track of what is going on both at home and abroad in space; to lay out a program for the United States at the Presidential level; [The details in the NASA case, of course, come from within NASA itself.] to make sure that these program elements are assigned among agencies; to arrange cooperation among agencies; and to settle disputes. We have a small staff headed by an Executive Secretary of subcabinet rank, Dr. Edward C. Welsh, and there are seven of us who are on his staff as professionals. This means that we are spread pretty thin over the total national program.

We have about 150 industrial briefings a year in our office, and we occasionally have to testify before Congress in the executive sessions. We do try to keep track generally of what is going on. In spite of all the things we have to do as a staff function, we are not as burdened as many people in NASA are with operating functions, so we occasionally have some time to think about the deeper, more philosophical side of space. Where are we going? What does it all mean? What are our problems of competition? As an outcome of some of these questions I got started into more detailed work of comparing the United States and Soviet programs. There are many people within Government who know quite a bit about the Soviet programs, but those who pursue it in depth usually have to work behind the walls of security and they have not faced the problem of trying to sort out those things which can be said in the open. I have had the advantage and privilege of doing that and I have found that it is possible to build a fairly comprehensive record, although it may not agree in every respect with the best information available to Government. I am reasonably confident, however, that it is not misleading in its general import as to the nature of the Soviet program and its relative status with our own.

So, based upon this public record of facts, I would like to make some comparisons and give something of a sketch of the Soviet program. There are many kinds of open records, and by now a substantial volume has been built up. The Russians themselves have released some information on their program. More is contained in the Goddard Satellite Situation Report, which gives orbital elements of spacecraft. Hindsight is a wonderful tool which makes it possible to keep going back and re-reading what has been said earlier, and in the light of

what has happened, many of the earlier things now make more sense. My own unclassified records in the office contain over 16 000 pages of Soviet published material on space translated to English. A couple of summers ago I made a conscious effort to re-read this record and to make some statistical analyses of what the Russians had said both as to what they had done and what they had predicted for the future. This review has helped to prepare this unclassified account.

QUANTITATIVE TRENDS AND COMPARISONS

The Soviet program still reflects its early start, its orderly nature in planning and content, its vigorous pursuit, its strongly competitive nature, and the fact that like our own it seeks multiple though interlocking goals.

There is no simple answer to who is ahead in the space race, and I hope that very few people are guilty of trying to answer that question in any very superficial way.

I am not going to disclose very many statistics as they are burdensome, but some are necessary. Even those in the space business lose track of how far and how fast we have been going. Overall, the United States has had 306 successful orbital or escape launchings and the Soviet Union 153 including Proton III. In number of spacecraft, including multiple launches, the United States Department of Defense has put up 290 earth orbiting payloads. NASA has put 103 into earth orbit and sent 14 more to the moon or planets. The Russians have put 174 into earth orbit, and sent 17 more on escape missions. This means that in number of successful flights of payloads to earth orbit or escape, the ratio is 2.1 to 1 in our favor.

This does not tell the whole story. I have made counts based upon several different methods of calculation, but whatever basis I take for these estimates, the Soviet lead in total weight of payload has held consistently six or seven years. There was one brief period when you might argue that Project Score in 1958 gave us a lead temporarily. But however one measures it, whether one tries to find out what true payload was, or whether one normalizes everything to a standard launch capacity to low orbit, the result is essentially the same. The Soviet lead has been growing larger every year. Even now that the Saturn and Titan III flights have come along, we have not yet begun to close the gap. This is something that is not emphasized in the newspapers, but it is not a classified statement either.

There is another comparison which is possible to develop from the record. Though this draws indirectly upon classified information, it has been certified safe to release because it doesn't give the details. The Soviet commitment to escape missions, flights to the moon and planets, as a relative share of total launch effort, successes and failures combined, has been 3.2 times as great as the US effort. They have made a far greater effort in relative terms at these escape missions than has the United States. They have also made a greater effort in absolute terms in number of flights and a still greater effort in the terms of the weight of payload committed to escape missions.

As far as the record of successes and failures goes, this is also drawn indirectly from classified sources which have been certified safe to summarize, there is really very little difference between the two countries. Both countries have been learning by doing. Considering just the launch and flight part of our space missions, our ratio is up to 92 percent successes this year. Overall, from 1957 to 1966, it is running at better than three quarters, and that includes the early days when things were a lot tougher in terms of chances of success. The Soviet figures are so close to ours that if it were possible to go over them in detail, one would note no significant statistical differences between the two countries. It means that although the Russians hide their failures as much as they can, they are basically working with the same problems that NASA is. This, I assume, is no surprise.

QUALITATIVE MAKEUP AND COMPARISONS

It is difficult to make a very detailed comparison of the two countries that will satisfy everyone because there are secrecy policies in both countries, and there are different emphases, philosophies, and priorities that involve value judgments between the two programs. It is rather interesting, incidentally, to hear Soviet reactions. It has happened to other people and it has happened to me on Radio Moscow that if we make any claim of our successes, the Russians say we "boasted" about this. If we credit them with anything, then we have been "forced to admit." So we either "boast" about our program or we are "forced to admit" things about their program. But in spite of the way propaganda occasionally misuses this information, and the frailties we all possess, I am trying to arrive at the fairest balance between the two programs because I think it is important to our understanding neither to overestimate nor to underestimate the people on the other side.

In general, almost every part of our broad space program has a Soviet counterpart. I cannot find anything that we are doing or planning in realistic terms for future missions that does not have some kind of a parallel in the Soviet program.

SCIENTIFIC SATELLITES

Some people claim that the Soviet program is purely military, and they also say that we have been tricked into a race to go to the moon while the Russians are concentrating on near earth military space. That is not necessarily true. They pursue science as well. Going back to some of the beginnings, you may recall it was something of a shock to us when Sputnik III went up back in 1958. We would have to rate it as an OGO in terms of its general capabilities, with a large number of experiments on board and about 3 000 pounds of payload. This operated very well for two years until it burned on reentry.

The Russians don't go in just for spectaculars. In the Kosmos series, they have had flights that are most nearly like our own Explorers. There have been 30 of these so far. All go out of Kapustin Yar, a small base near the Volga River. They all fly at a 49 degree inclination so it is not nearly as varied as our space program, but the times of day of launch and the kinds of orbits as to eccentricity vary quite a bit. These are not recoverable. We don't know precisely what the weights are, but measurements of their brightness and the fact that they are probably spin stabilized and a few other things suggest that they may be somewhere between 300 and 1 000 pounds each.

They have had a few other satellites in their scientific program. The Elektrons have gone up in pairs, one of each pair going to 4 000 miles apogee and the other to 40 000 miles. The experiments described don't account for all the weights and the solar cell arrays, and some think that there are other experiments that have not been identified, something other than just the radiation and particle measurements advertised. And then, of course, there is the Proton series, three of which now have been orbited. They carry cosmic ray experiments measuring energies all the way up to 100 trillion electron volts. These ships weigh 26 903 pounds, which makes them a pretty good size by any standard.

In terms of all of the things that the Russians have done and published I think we can say that our program in science is stronger than the Soviet program, that we have done better perhaps at interpreting the results that have come back. But at the same time, the Soviet effort in scientific satellites is a large one.

Unmanned Lunar and Planetary Flights

This is very curious effort and illustrates well the difficulties of trying to make a direct comparison of how the two countries stand. In this area their

commitment has been relatively, and in absolute terms, as I said, larger than our own. Their payloads have been far heavier. Some of them have been more complex, some have been less. But what has been most startling is their persistence in the face of many failures in this area. The lunar program in particular has had many difficulties. For a long time, there wasn't much to show in results, after the success of Luna III back in 1959, which took some rather low-grade pictures of the far side of the moon; nonetheless it was an interesting tour de force to get those pictures home as they did. Their program on soft landings began in January 1963, and we can establish this from completely unclassified sources in the public record. Only recently did the Russians finally admit that many of these flights were failures. They had the failure in January of 1963, and Luna IV, V, VI, VII, and VII all failed as part of this program. Kosmos 60 was really a lunar failure as part of this program. Luna IX did make a landing but has since been outdone in the technique that we have used for the landing and the kind of results which have come back from Surveyor. Kosmos 111 was a lunar failure, and their Luna X then went into lunar orbit. Our hopes are that when we match that particular thing, we will outdo it in actual results to be obtained.

The planetary program is especially striking. The Russians have allowed no planetary window for Mars or Venus to go unused without multiple attempts since 1960. There now have been 17 flight attempts. The first two did not get to earth orbit and those are the only two such orbital flight failures that the United States Government has ever announced to the public. In general, our policy, for reasons of security I suppose, has been not to disclose Soviet failures, but this time we did so. They had the two Mars attempts in 1960, two Venus attempts in 1961, three Venus attempts and three Mars attempts in 1962, two more Venus attempts and a Mars attempt in 1964, and a late Mars launch and three more Venus attempts in 1965. So all of these add up to 17. Incidentally the last Mars attempt did not get off within the window and it followed later then, in 1965, as Zond III which was programmed to take pictures of the far side of the moon again and then to continue as if it were on its way to Mars and to send these pictures back over ever-greater distances. What is curious is that of all the attempts the Russians have made at the planets, the one which seems to have performed as it should was Zond III, which wasn't going much of any place and particularly not toward any planet. But one of these times that program undoubtedly is going to work. It is also interesting that the commitment of hardware, the weight of payload, to their planetary program has been 15 times as great as our own, so this represents a very considerable investment and a real determination to keep working in this field.

Applications Satellites

There is no doubt whatsoever that we have held a marked lead in this field because our priority was such that we put an early emphasis upon practical results in communications, in weather satellite flights, in navigation, in geodesy, and so forth. The Soviet ability to do applications probably is there, but they have been slower to set the priorities. Now some of these priorities have apparently been rearranged and they are beginning to do some things. Nobody can take the credit away from us for being the first and then having had second generation very practical craft which do very excellent jobs in these areas. Looking first at the weather side, the two countries have agreed to exchange weather data over the "coldline," but the Russians have yet to deliver satellite pictures. However, development is underway, and the Russians have revealed that Kosmos 45, Kosmos 65, and Kosmos 92 were all satellites carrying advanced weather sensors on board and taking pictures, and that they were successfully recovered after flight. They have also, as you know from relatively current news, released pictures taken by a Molniya satellite from near synchronous altitudes to give a view of the weather patterns over the whole Eurasian land mass. When it comes to communications, of course, it is now our Early Bird that floats in a fixed position relative to the surface of the earth over the Atlantic and is available 24 hours a day. The Russians launched something they call Kosmos 41 which went into elongated orbit, highly eccentric, with its apogee over the northern hemisphere. They did not announce its full purpose. I am glad I had already gone on public record as saying that it was a communications failure. Perhaps it was, and perhaps it wasn't, but then came the Molniya flights of which there have been three announced, and these have gone into the same kind of orbit. It makes a certain amount of sense from the Soviet point of view. An elongated orbit is easier to achieve than a true synchronous orbit and yet it does a very good job with the 12-hour orbit positioned so that every day one of its apogees comes over the Eurasian land mass and the payload is available for 8 or 9 hours at a stretch without interruption for joint use by ground stations in places like Moscow and Vladivostok, and of course it has also been used for color television programs between Moscow and Paris in both directions.

In the navigation area, we have something we called Transit, though that name has disappeared from the public record. We do say that we put up navigation satellites and have an operational system. Premier Kosygin announced that navigation was one of the three application programs which the Russians actually had flying at that time. He said weather, communications, and navigation were the three kinds, and if one would try to guess what were

the Soviet navigation satellites, my own candidate would be another part of the Kosmos program, those that have gone up in multiple launches. Some of them go up as many as five at a time, 10 in one month. There are 24 of these that have been orbited. They are in relatively circular orbits several hundred miles up and they are all inclined at 56 degrees to the equator. Precisely how they are used and whether they have other uses such as in communications is one of those things which has not been revealed. But the fact that there has been no talk about it suggests to me that there is probably a military navigation system. Also, by coincidence, two of these Soviet satellites have radio isotropic power supplies on board and the only programs where we have used such power in this country happen to be in our navigation satellites. I hope I am not being led too much by this coincidence into a false conclusion about these flights.

Military Space

The United States and the Soviet Union have pledged and declared that they will not orbit weapons of mass destruction. However, more recently the Russians have paraded in Moscow some vehicles that they describe as orbital weapons and that are in their inventory. The United States has no such program. The majority opinion in official circles in this country is that it just does not make sense in regard to the problems of maintenance, command and control, and all the rest of it, as compared with ICBM's in silos or having missiles on Polaris submarines at sea. But whatever the possibilities are, both countries have limited insurance available in an antisatellite system.

Quite aside from weapons in orbit, there are many other things that are possible in military support operations in space. These are passive in nature and exploit the right of free passage which has been exercised ever since Sputnik I flew over much of the world. Both the United States and Soviet Union claim that their activities in space are peaceful, and certainly in the sense of helping to maintain the peace, ours are consistent with our declarations in the Space Act. The activities of the Department of Defense are no less peaceful than those of NASA because that is our national policy. NASA has no monopoly on peaceful activities here. And of course when it comes to charging others with less than peaceful intentions, it is a thing that a third country would find harder to judge in a way which would satisfy everyone. What is aggressive may be more of a state of mind than a matter of the kinds of hardware which are in orbit. So far as the satellite is concerned, data gathered and transmitted are a very impersonal kind of thing. We certainly know that our own country does not have aggressive intentions in space. Once upon a time all the potential missions of a military nature in space were discussed fairly freely. Now it

seems to be national policy to play this in rather a low key way except that we do conscientiously report every flight to the United Nations with an orbital elements report. Also we report our failures, and we report our debris. The Russians tend to be rather sanctimonious about their activities and extremely evasive about what they are doing with some of their flights. They only report payload successes and all of them are labeled as being scientific in nature.

They have made their Kosmos label a cover for many kinds of activities. For one thing, we know from the time of launch and the behavior of some of the Kosmos flights that they are a cover for lunar and planetary escape missions which have failed to leave earth orbit. There is nothing classified about this declaration. It is just in the nature of things. This was also officially acknowledged by Mr. Webb back in 1962 on September 1, when he reported some instances of Soviet failures. At that point the Russians had not begun to label these things as Kosmos. As a matter of fact, they went through a brief period not mentioning these partial failures at all. They learned from experience that it is better to name them but not disclose their purpose and thus escape the blame for operating with that particular kind of secrecy.

I have already suggested that some of these Kosmos satellites, those at 56 degrees inclination, could very well be for navigation, they could also be for communications; indeed, they may have several missions. But even more interesting is one large group of Kosmos flights which fly mostly at 65 degrees inclination, a few at 51 or 52 degrees, and a few at 72 or 73 degrees. Back in May of 1960 came the first of the craft they called satellite spaceships. These were the original precursors to the Vostoks, and many of them carried dogs. We learned to recognize them, how they flew, from their brightness, that they were stabilized, and that they had quite a flow of telemetry out of them.

Then came the Kosmos series and it was announced as something which came from several different launch sites within the USSR. We quickly identified from quite simple open sources, as other countries did too, that at first these were coming from Kapustin Yar. But the fourth one came from Tyuratam, the largest Soviet launch base, the only base which up to that time had been used for ICBM testings. Kapustin Yar is an intermediate range missile base normally. The fourth Kosmos had all the observable characteristics of the Vostoks and flew at a 65 degree inclination with low circular orbit. It was announced as recovered after about three days and since that time there have been more which are similar, some 52 flights of this nature.

It is very hard, particularly since there have been very few results announced from them, to imagine any mission for 52 heavy payloads in the

10 000 pound class and up, which now routinely stay up for just eight days. They come down before the carrier rocket so it is a pretty good sign that they are called down, and they fly these repetitive low orbits and are spaced about two a month, roughly, and rarely overlap, with one exception. Their only mission that I can think of is that they are picture-takers, and I am helped by the fact that Premier Khrushchev, when he was still in office, offered on two occasions to trade pictures of military bases taken by satellites. The Soviet Government officially has not acknowledged such flights. Incidentally, Khrushchev also suggested at one time that it would be far better for us to watch Cuba by satellite than fly the U-2 over it and risk having the U-2 shot down by the Soviet surface to air missiles. At the very least, Khrushchev's words pull the rug out from earlier Soviet charges that such activities only happen in Western countries and are highly provocative and dangerous.

Manned Space Flights

This has been one of the areas of strong Soviet effort and it is one where the assessment has had to change within the last year because of our own very great progress in this country. But just look at some of the earlier history of this. Before Gagarin went into orbit, the Russians had a hundred orbits of controlled flight experience with the Vostok craft and they used at least six dogs. When we sent John Glenn up, we had taken as many precautions as we could. We had only three orbits experience with the Mercury system including the use of one ape. The Russians have had biological data from orbit going all the way back to 1957 with Sputnik II when Laika was up and alive for at least a week. The Vostok craft, as you recall, was over 10 000 pounds and as they have moved on to the Voskhod, the weight has moved up; the second one was 12 520 pounds as reported by the Russians at Paris to the FAI. In the early days you will recall we had some unpleasant comparisons to face in terms of amount of orbital time, but that balance has swung very markedly now in our favor with the long duration achieved in the Gemini flights. However, the basic Vostok and Voskhod systems, which are similar to each other, plus those unmanned Kosmos flights, which have all the appearance of being the same basic hardware, have now passed the 7 000-orbit level of experience of successful flight which should give the Russians a pretty high degree of confidence in the system. The fact that we have done so well in the past year or so of course is very, very encouraging. The thing which is so surprising to all of us who follow these matters is that the Russians have not demonstrated successful, sustained rendezvous station keeping, docking, and the kind of maneuver in orbit with manned craft that we now have seen accomplished in this country.

Why haven't they? I personally suspect that they are skipping the Gemini stage. The Voskhod was not as much an upgrading over Vostok as Gemini was over Mercury. I suspect that they are going on to their own equivalent of Apollo, and this accounts for the long gap. It is the kind of gap we would have had in this country if we had moved from Mercury to Apollo. We decided on Gemini as an interim step and I hope in net balance it supports Apollo.

Comparative Rocket Thrust

This clearly has been an area where the Russians have had an advantage for a long time. They went on a different path from us to some extent. I know that the people like Dr. von Braun and others at Marshall must feel very poignantly the decision in the early days to go the Vanguard route first of all and to keep it entirely separate from our military effort and to do satellite work with a marginal rocket. The Russians from the outset decided to use military hardware and took their early ICBM, which had been designed before the thermonuclear breakthrough came along, so that their standard launch vehicle ever since the early Sputnik has been something that was roughly the equivalent of a larger Titan II in its lift capacity. In the first three flights it did not have a proper upper stage on it so that a fairly large carrier rocket went into orbit, somewhat like Project Score. Since that time they have added an upper stage they used for their early lunar flights, and the pictures released are clearly the same pictures that have come along with the Vostok. So they have used this same communication for manned flights putting up over 10 000 pounds in earth orbit; and with the better upper stage now they are able to put an announced 14 000 pounds into low earth orbit to serve as a launch platform for escape missions. So this now is a pretty familiar vehicle to them. They have announced and filed at Paris a report that the combined thrust of all stages of the Vostok class launch vehicle is 1.32 million pounds of thrust. They also told us, for what it's worth, and we have played with these figures for a long time, that it has a total power output of about 20 million horsepower.

Coming down to the more recent events, they have the Proton class vehicle. This is the one that has been used for 27 000-pound payloads. They have not told us what the thrust is, but they have told us that the total power output is over 60 million horsepower. Therefore, we have concluded that the first stage thrust is probably somewhere between 2.5 and 3 million pounds. We also are quite sure that we have not seen an optimal upper stage on it. It probably has a lift capacity when an existing upper stage is put on it of somewhere between 40 and 60 thousand pounds to relatively low circular earth orbit. So probably, it is ahead of the uprated Saturn once it gets that staging. On the

other hand, for the moment the United States, with the effort of Marshall, may hold the lifting record with 58 537 pounds. The announced Soviet record is almost 27 000 pounds for the payload and an unstated weight for the accompanying but separated carrier rocket in orbit.

That means in a sense that we are almost running neck and neck, although I think the United States does have some advantages. We are using high energy propellants and doing it very successfully, particularly with the experience with AS 203, and we don't have this kind of indication yet on the Soviet side. Mr. Webb has suggested that the two countries are running at a very parallel level. He thinks, as you have heard in his recent statements, that the Russians are going to tend to beat us by a little bit in time and a little bit in weight on these steps, but until it happens of course we don't know for sure. He suggests that the Proton class is not the end of the Soviet line any more than the uprated Saturn is the end of the line for the United States. In the next year or so as our Saturn V comes out we will have to see whether there is a Soviet equivalent and how big it is. In terms of the operational use, they have had the competitive advantage since 1957 up to this point, of a vehicle basically with a lot of experience which can put up to 14 000 pounds in orbit as against our most common rockets that were smaller, and only recently have we added rockets that are quite a bit bigger than the basic Soviet vehicle. Of course we haven't had as many flights yet with these new vehicles, but the country owes Marshall a tremendous debt of gratitude for the success and quality that has come, the unblemished records on these flights.

COMPARATIVE SPACE GOALS

What about the goals of the two countries? I really don't find too much difference between the announced goals of the two countries. I do find, from my review of all those thousands of pages in my files that I have collected over more than ten years, that the Russians, at every level from the project engineer up to the very highest level of their government, and consistently over all of these years, have set very ambitious goals. These are without an exact time table, although increasingly they say they are going to beat us to the moon if they can, and that their goal is to put Soviet man throughout the entire solar system -- a very ambitious goal. They look forward ultimately to colonization of the planets by Soviet man. In the short run they have capitalized upon headlines and prestige; they have opened up new scientific frontiers; they have been gaining military information. Now they are moving ahead to more complex missions with further practical applications, and they are also paying great

attention to the technological spin-off of space. It really doesn't sound very different from many parts of our own program. For the next period beyond that I am sure that they are trying to build a versatile, economical space transport capability that can open up the solar system.

The Moon Race

What about the race to the moon? I believe that that is language which isn't always helpful, but nonetheless the public is going to tend to view it as something of a race. Both countries clearly are trying to build a broad capability to operate in space. Going to the moon is a technological bench mark, a way of organizing resources with a time table, a way of winning public support. It is not necessarily an end in itself. For a period some people thought the Russians were not in this competition or were not trying to go on the same time scale, and they love to quote, as the New York Times did, an occasion when Khrushchev was asked about this in Denmark and said in effect "Well, we have no plans to go at this time. We will watch what the Americans do with great interest. We will profit by their experience." This made lots of headlines in this country to the effect that the Russians were out of the "race." It was only a few weeks later when a group of visiting American businessmen called on Khrushchev and he threw one of his temper tantrums and shouted that it was the lying American press misquoting him. He had never said the Russians were not going to the moon, that they were working hard on this problem. Incidentally, this second Khrushchev report did not get the same press attention in our country, which is regrettable. Of course, with the successful lunar flights of this year, the Russians have been more positive in saying that they do plan to get to the moon before 1970 and the cosmonauts in recent days have said that when we Americans land on the moon we will be greeted by Soviet cosmonauts. That may be just bravado, since they are cosmonauts. If that is not official Soviet policy, they still get the propaganda benefits, and if it is not true, the Soviet Government is not held responsible. As you know, our own President has said that Americans will not only get there before 1970 but will be the first ones to arrive. Somebody is going to be right and someone wrong with regard to such predictions when the first landing comes about. Although I think we have a good chance, we know how good our program is, and there are many uncertainties still about the Soviet program; it would be highly dangerous for us to assume that they are not trying and trying very hard.

CONCLUSIONS

We still live in an age when there are some people who act as though space flight were not here to stay, that we are near the limits of what is possible in terms of cost and reliabilities and so forth. Some of these people with such conservative views even have technical and scientific training. The history of technology and science has been filled with past examples, particularly in my own field of transportation economics, of something of a cultural lag with people balking at what was coming. But fortunately the younger generation understands what is coming, that we are on the way to becoming what President Kennedy once labeled a space-faring nation. I think that in and out of Congress there are enough key Americans who understand this, so that we will continue to push space. It is something important. Russians also feel this way about it.

The knowledge to do well in space is not the monopoly of any one country or even any two countries. It is something that grows out of a universal heritage of all mankind, and I think in the years ahead as costs come down, even with the great backlog of experience which we have in this country, there will be others who will enter this business rather competitively. We do face a strong Soviet challenge which is immediate. If they were to disappear I hope it would not change the pace of our program. We do have to recognize Soviet rivalry as one of the political realities. The challenge is one which I feel involves far more than prestige. It is one which can be rewarding to us materially and can be useful to mankind in promoting the peace, and in making human beings feel that they have a truly significant role in the universe.